5.3.3 Turning Movement Survey

The turning movement survey for this study is important for providing details on the directional movements of traffic. The intersections where this survey was executed are shown in Fig. 5.4, with the survey sheet shown in Tab. 5.5. The details of its execution are as follows:

- Survey Time: Morning peak and off-peak times over a period of 3 days.
- Measurement Intervals: 15 minutes.
- No. of Survey Stations: 16 stations representing major junctions in the CMR.
- Vehicle Class: 8
- Survey Methodology: Measurements were carried out for all the directions of travel (left, right, straight) by a single team of enumerators that did a 15-minute count for each

5.3.4 Travel Speed Survey

This survey is important in that it provides observed travel speed data that can be directly compared with modeled travel speeds in the calibration of the traffic demand model. The routes where this survey was carried out are as shown in Fig. 5.5, with the survey sheet shown in Tab. 5.6.

- Survey Time: Morning peak and off-peak times over a period of 3 days.
- No. of Measurements: 2 times per day for the 8 survey routes for both directions, with speeds recorded at the appropriate locations along each route.
- Survey Methodology: A test car was used and average travel speeds for the different locations along the survey routes obtained by travelling along with the traffic flow (i.e., the average car method was applied).

5.3.5 Bus Passenger Interview Survey

This survey, like the bus passenger volume survey, was a supplemental survey and not initially considered. The importance of this survey is to determine whether bus riders are captive users for modal split purposes. The locations where the survey was executed are shown in Fig. 5.6, with the survey sheet shown in Tab. 5.7. The details of the survey execution are as follows:

- Survey Time: Depending on whether or not there was existing data, either a 6 hour sur-
- vey (morning or afternoon) or an all-day survey was carried out. Also, at important bus
- locations, the all-day survey was done for 3 days.
- Survey Items: Access mode, egress mode, and car ownership.
- Survey Methodology: Bus passengers waiting at important bus stops and terminals were interviewed at random and their answers recorded on site.

FINAL REPORT

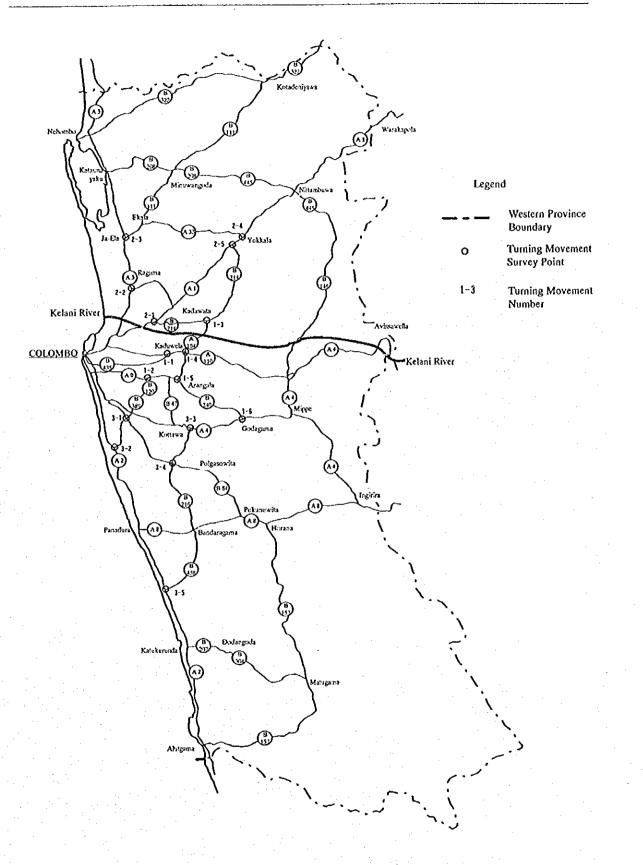
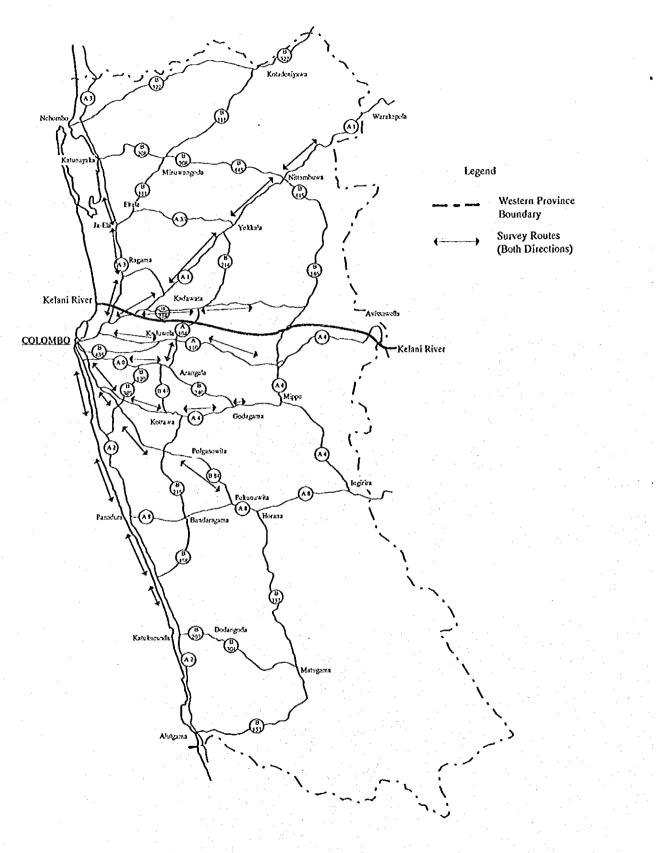


Fig. 5.4 Turning Movement Survey Points

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OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-14

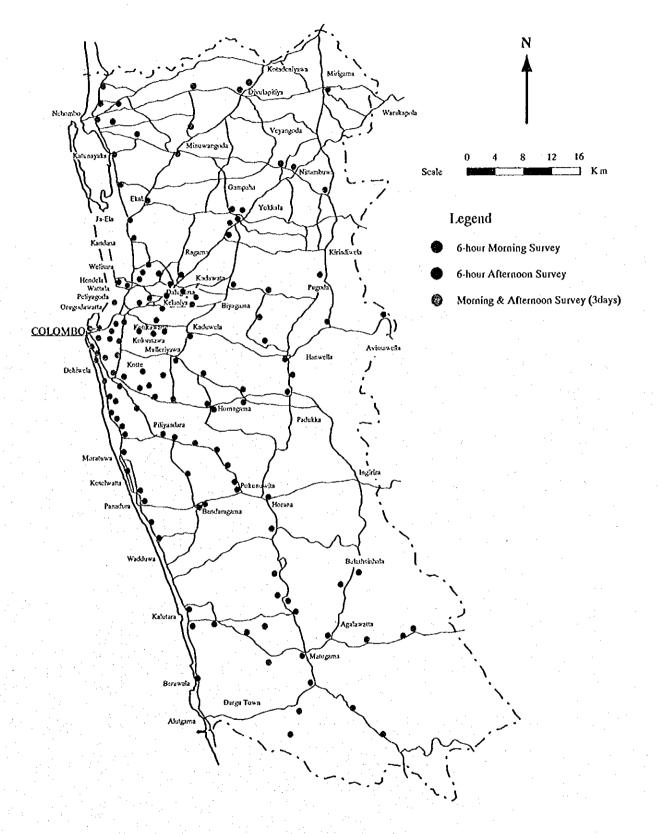
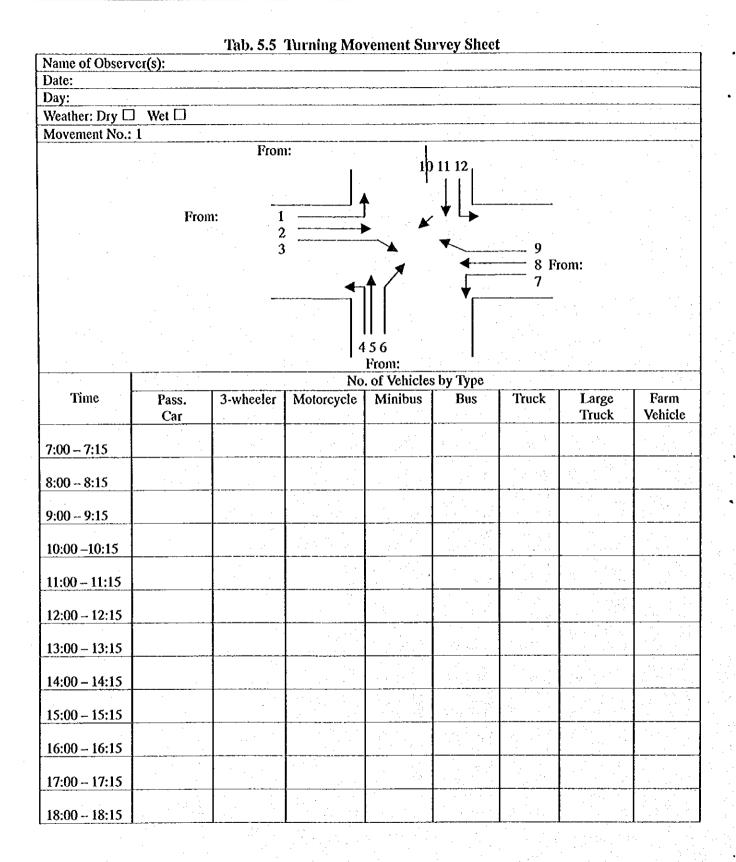


Fig. 5.6 Bus Passenger Interview Survey Locations

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-15



OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-16

Tab. 5.6	Travel	Time	Survey	Sheet
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Name of Recorder(s):				
Location:		· · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	·
Direction: From:	To	·	******	
Route Name:		· · · · · · · · · · · · · · · · · · ·		:
Date: Day:				
Run:				
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Junction	Cumulative	Cumulative Travel	Special	Sect.
Name	Sect. Length (km)	Time (min:sec)	Notes	Travel Time
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OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-17

EINAL REPORT

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OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

JICA STUDY TEAM ORIENTAL CONSULTANTS CO., LTD

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5.3.6 Traffic Survey Results & Analyses

Traffic survey results and their analyses are discussed below. For detailed traffic survey data, refer to Annex I (Traffic Survey Data & Traffic Model Results).

1) Roadside OD Survey

Sampling Rate

The number of vehicles that were sampled and the sampling rates for the 16 OD survey points illustrated in Fig. 5.3 are noted in Tab. 5.8. As Tab.5.8 indicates, the average sampling rate for passenger vehicles was 13.5% and for freight vehicles 29.6%. The goal was to achieve a sampling rate of 10%. Although this was realized on average, it was not possible to achieve this at all the sites due to reasons such as lack of police staff, bad weather, and difficulties in stopping vehicles at highly congested locations. However, except for the passenger vehicle OD survey at Site 4, the sampling rates generally seem to be sufficient.

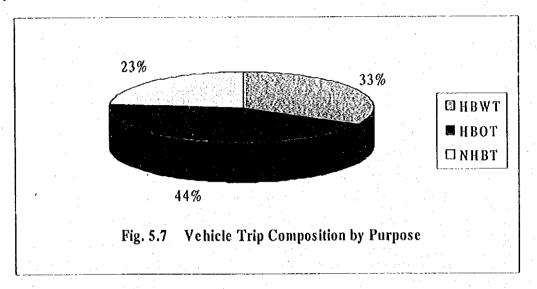
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Site	Total No. of Pass.	Sampling Rate for	Total No. of Freight	Sampling Rate
	Veh. Sampled	Pass. Veh.	Veh. Sampled	for Freight Veh.
: 1	1035	3.1%	742	11.5%
2	892	4.4%	324	9.5%
3	712	8.7%	489	26.9%
4	916	2.2%	281	19.7%
5	1345	6.0%	438	47.5%
6	1345	8.0%	366	43.5%
7	830	3.1%	385	11.6%
8	413	7.2%	255	15.0%
9	111	4.4%	142	12.8%
10	496	16.9%	428	29.3%
11	520	6.4%	423	15.3%
12	580	19.8%	485	21.3%
13	549	34.0%	458	25.6%
14	554	43.3%	169	100.0%
15	720	33.8%	572	68.5%
16	905	14.4%	549	34.1%
Average		13.5%		29.6%
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Tab. 5.8 OD Survey Sampling Rates (12 hours)

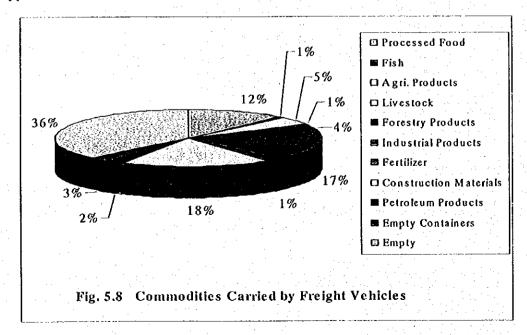
OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-19

Vehicle Trip Characteristics

Passenger vehicle trips by purpose were categorized into 3 types: home-based work trips, home-based other trips, and non-home-based trips. As Fig. 5.7 indicates, home-based other trips accounted for the largest proportion of trips at approximately 44%, with home-based work trips being next at 33% and non-home-based trips the smallest at 23%. Note that school trips are included in home-based other trips.

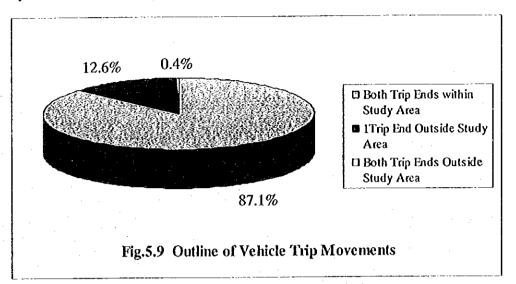


As for freight vehicle trips, excluding those trucks that were empty (36%), the most ferried items according to those vehicles surveyed were construction materials (18%), industrial products (17%), and processed food (12%). The proportion of vehicles that were carrying other types of commodities totaled about 17%.



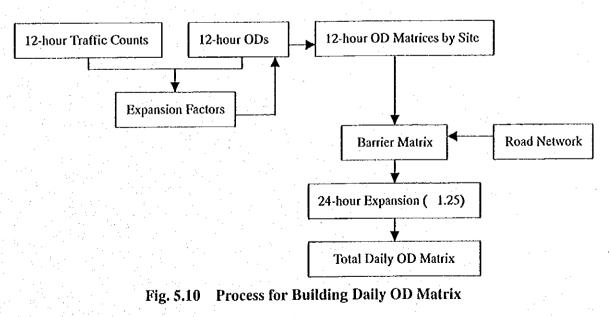
OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-20

As for total vehicle trip movements, Fig. 5.9 indicates that the vast majority of vehicles surveyed (or 87.1%) traveled within the CMR. As for vehicle trips with one trip end outside of the CMR, these accounted for 12.6% of the vehicles surveyed, while only 0.4% of the vehicles questioned were through trips.



Establishment of OD Tables

Daily OD tables for freight vehicles and for the above-mentioned trips purposes for passenger vehicles were prepared with the assistance of the University of Moratuwa's Dept. of Civil Engineering (Transportation Engineering Div.). The process used to construct daily OD tables is shown in Fig. 5.10. The present OD table (all modes and all purposes) is shown in Tab.5.9.



OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-21

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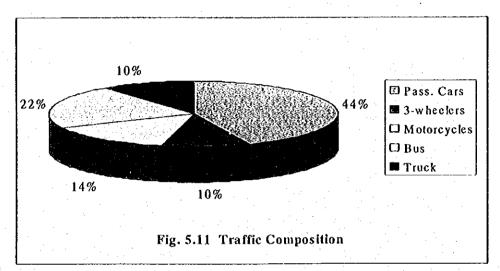
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FINAL REPORT

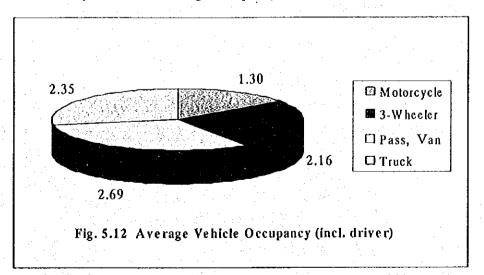
Vehicle OD Matrix for 1999 Vehicle Type : All

2) Traffic Volume Survey

The composition of traffic, as determined by the traffic volume and roadside OD surveys, is shown in Fig. 5.11. As the figure indicates, 58% of the vehicles on the road are private passenger vehicles (i.e., cars and motorcycles), while 22% of vehicular traffic consists of buscs (regular buscs and minibuscs). Freight vehicles and 3-wheelers each accounts for about 10% of total traffic.



Excluding buses and school vans, the average occupancy of the different vehicle classes is as shown in Fig. 5.12. Except for motorcycles, all the different vehicle types had an average occupancy greater than 2, with passenger cars having the largest average value of 2.69 persons per vehicle. Motorcycles had an average occupancy of 1.30.



As for the actual traffic volumes that were surveyed on site, they are as shown in Fig. 5.13 below.

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

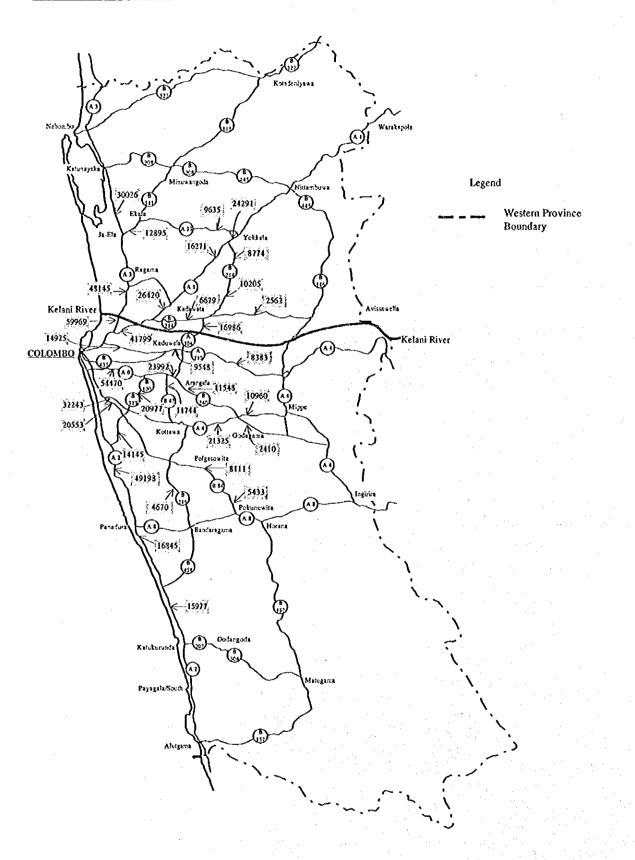


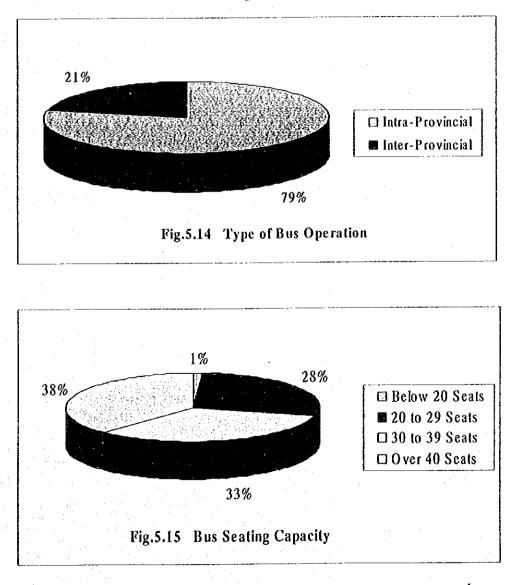
Fig. 5.13 Average Daily Traffic Volume on Major Arterials in Colombo

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PAGE 5-24

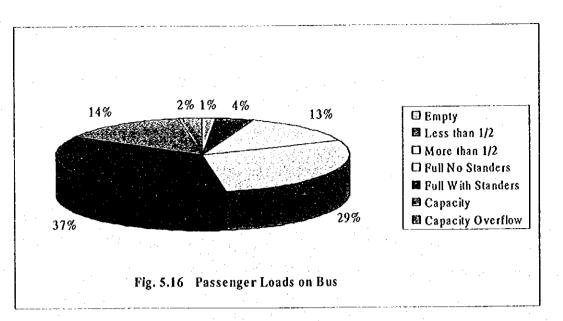
As Fig. 5.13 indicates, daily traffic flows on arterials near the center of the city are experiencing large volumes of traffic. On A3 at the point nearest Colombo, more than 59,000 vehicles were surveyed coming and going to the city. Of the 34 locations that were surveyed, 5 experienced traffic flows greater than 40,000 vehicles per day and 7 flows greater than 30,000. This indicates that portions of the road network are heavily used and experiencing congestion.

3) Bus Passenger Volume Survey

Three important pieces of information were derived from the bus passenger volume survey: type of bus operation (intra-provincial or inter-provincial), bus capacity, and bus usage conditions. Each of these is shown in the three figures below.



OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO



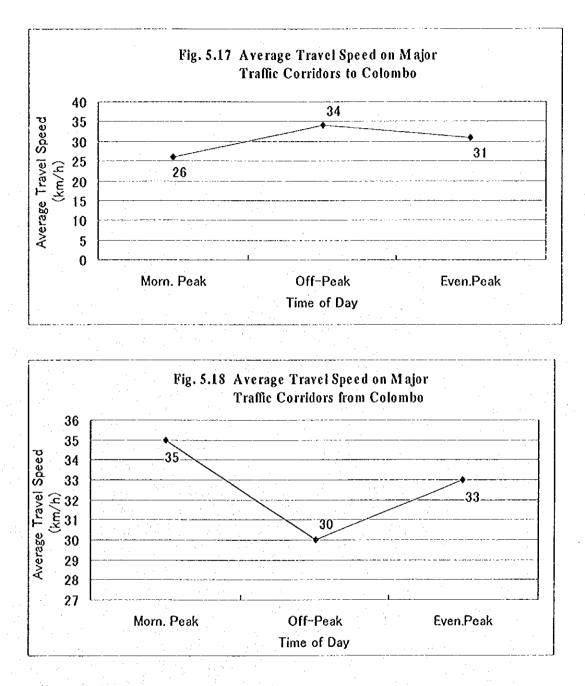
In Fig. 5.14, it can be seen that the vast majority of buses observed (or 79%) operate within the CMR (or Western Province). Of these, only 1% had a seating capacity of less than 20 seats, while 38% had a capacity of more than 40 seats and 33% a capacity between 30 to 39 seats (see Fig. 5.15). The other 28% of the buses observed had a seating capacity between 20 to 29 seats. As Fig 5.16 indicates, buses are used rather extensively, with 53% of those observed being full with no standers or at capacity or greater. If being able to sit down is a criteria for using a bus, then 82% of the buses observed would be unattractive choices for travel.

4) Turning Movement Survey

The purpose of the turning movement survey for this study was solely for grasping the directional flows of traffic at important junctions and not for obtaining data to carry out detailed analyses of intersection design. Refer to Annex 1 for detailed information on the directional flows of intersections.

5) Travel Speed Survey

According to the travel speed survey results, average travel speed on major traffic corridors in Colombo is in the range of 30 to 35 km/h, depending on the time of day and direction. In the direction of Colombo, the morning peak has a minimum travel speed of 28 km/h, which increases to 34 km/h during the off-peak and drops back down to 31 km/h in the evening peak (see Fig.5.17). As for the direction away from Colombo, the morning peak has the highest speed of 35 km/h, indicating that many commuting trips are in the opposite direction. This drops to 30 km/h in the off-peak and rises to 33 km/h in the evening peak (see Fig.5.18).

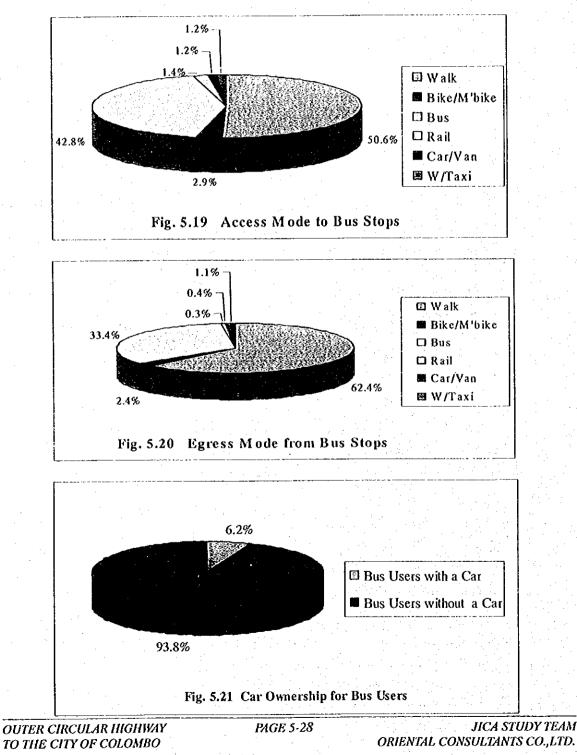


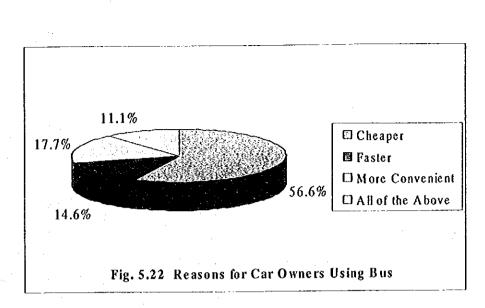
6) Bus Passenger Interview Survey

The main results of the bus passenger interview survey are shown in figures 5.19, 5.20, 5.21, and 5.22 below. As the first two figures indicate, the mode used most often to access and egress a bus stop is walking at 50.6% and 62.4%, respectively. The mode used next most often is bus, meaning that people are perhaps riding a bus from a minor route to connect with another bus that plies a major route. Other modes, such as car and rail, as connectors to bus transport are insignificant in terms of use, indicating that the concept of park-and-ride is not

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being practiced. It also seems to indicate that inter-modal transport does not yet exist on any sort of large scale in Colombo. Another important result of the survey was that only 6.2% of the bus users surveyed owned a car, indicating that almost all of the people who ride buses are captive users. That is, they use the bus because they have no choice (see Fig. 5.21). For those who own a car and use a bus, they do so mainly because it is cheaper (56.6%). Only 17.7% said they use a bus because it is more convenient, while another 14.6% said they use a bus because it is faster.





5.4 Building of Traffic Demand Model

5.4.1 Forecasting Methodology

The traffic demand model employed the traditional 4-step estimation method contained in the JICA STRADA (System for Traffic Demand Analysis) package, which consists of the steps of trip generation/attraction, trip distribution, modal split, and traffic assignment, to calculate the traffic demand for the CMR and OCH. The forecast years for this study were 2010 and 2020. An outline of the basic structure for forecasting traffic is shown in Fig. 5.23. Note that this process was applied only to the estimation of trips that occurred within the CMR. For trips that begin or end outside of the CMR, calculations were carried out using a simple projection method. As for through trips, since they were insignificant in terms of overall volume they were not taken into consideration (see Fig. 5.9).

5.4.2 Outline of Traffic Model Data and Development

Introduction

The study area consisted of the Western Province (or CMR) and was divided into 31 zones as shown in Fig.5.24. The traffic demand model for this area incorporated only the arterial road network. That is, the railway network was not taken into consideration in this study, based on the assumption that modal shares would remain stable. Below, an outline of each of the steps of the traffic demand model, as well as the development of the model itself, for determining the demand for this network is described.

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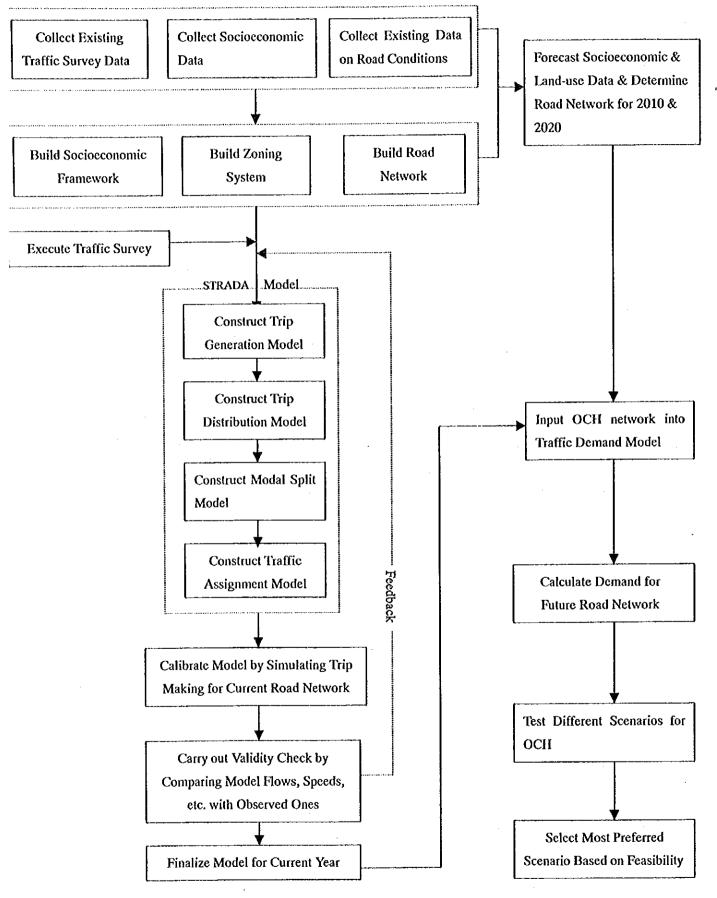


Fig. 5.23 Process for Forecasting Future Traffic Demand

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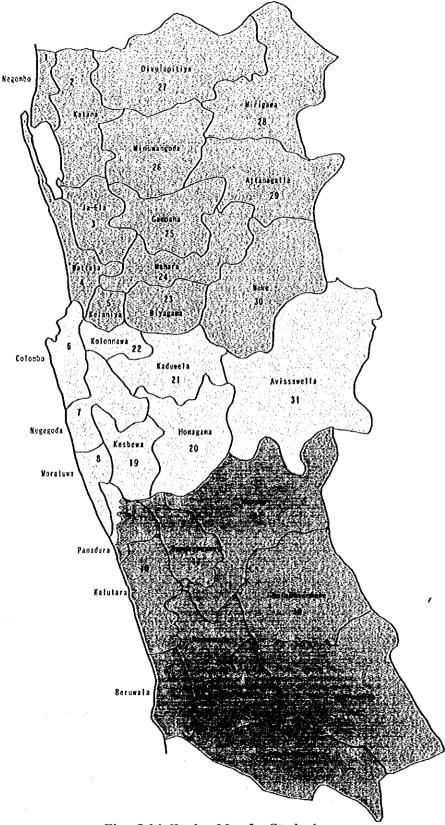


Fig. 5.24 Zoning Map for Study Area

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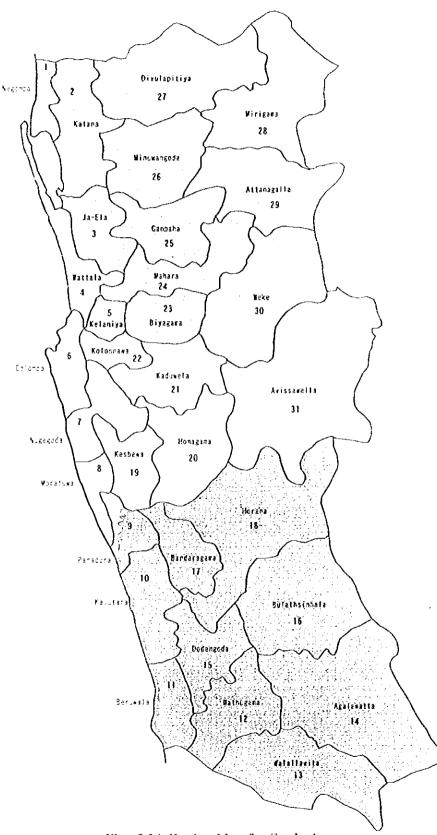


Fig. 5.24 Zoning Map for Study Area

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Trip Generation/Attraction

In order to model trip generation/attraction, it is necessary to use trip control totals to ensure that realistic estimates of future traffic demand are obtained. Below, the process for estimating the trip control total and trip generation/attraction values is described.

1) Trip Control Totals

Trip control totals for the CMR were established using the relationship of 'vehicles per capita' and 'vehicles generated' per zone. Based on the traffic survey and socioeconomic data gathered in Colombo, it was assumed that the number of trips per vehicle will decrease as the number of vehicles increases as a result of less intense usage. This resulted in the derivation of the control totals shown in Tab. 5.10. As this table indicates, annual growth in vehicular trips will be about 7.37% until the year 2005 and then drop to 4.34% and 3.32% for the periods of 2005 to 2010 and 2010 to 2020, respectively.

Tab. 5.10	Total Future	Daily Trips for the CMR
Year		Daily Trips (Control Totals)
1999		289,100
2005		443,000
2010		548,000
2020		759,000

2) Zonal Trip Generation/Attraction

In order to model vehicle trip generation and attraction, the CMR was divided into 31 zones as shown in Fig. 5.24. This division was based on administrative boundaries. Then, the correlation between various socioeconomic factors and vehicle trip generation/attraction by vehicle type and trip purpose were checked and models constructed. The socioeconomic factors that were considered for trip generation/attraction modeling consisted of employment, population, vehicle ownership, and income. Calculations of socioeconomic factors are described in Chapter 4. The vehicle types considered were cars, 3-wheelers, motorcycles, buses, and trucks. As for trip types, these consisted of home-based work trips, home-based other trips, and nonhome-based trips. The calibrated models provided daily (24-hour) trip generation/attraction figures for a typical weekday.

As for trips with a trip end outside of the CMR, it was assumed that the share of these trips

(i) A set of the se		
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would remain the same in relation to total trip making in the CMR and that they would grow in proportion to increases in the number of total CMR trips.

Trip Distribution

Trip distribution simulates the travel patterns of urban travel by applying the concept of ease of travel. Ease of, or deterrence to, travel is usually defined either in terms of cost, time, or distance. In congested urban areas, time or cost is usually used, since distance is not an accurate representation of actual travel. On the other hand, in this study, zonal distance was applied, based on the fact that Colombo has relatively high average travel speeds.

The inputs for trip distribution are the trip ends determined from the roadside OD survey and the actual travel distance between zones. The key outputs are the observed distribution lengths by vehicle type and trip purpose, which are used to calibrate the distribution model together with screen line data.

Trip distribution models were constructed for the 11 types of trips described above (i.e., bus trips, truck trips, and home-based work, home-based other, and non-home-based trips for passenger cars, motorcycles, and 3-wheelers).

Modal Split

The purpose of a modal split model is to simulate the selection process that travelers go through in choosing a mode of transport by which to travel. In this study, it was decided that a modal split model would not be constructed for the following reasons:

- 1) More than 93% of bus riders are captive users (i.e., they do not possess a car) and are unable to switch to private transport (see Fig. 5.21). In addition, the current low levels of service on buses discourage private vehicle owners from using a bus. That is, there is no realistic choice between private transport and buses. Travelers faced with the choice of either traveling by car/motorcycle or bus will almost always choose the former.
- 2) Trips by rail, according to recent estimates, account for only about 5% of the total person trips made in the CMR.

Given the above, it was decided not to construct a modal split model. As a result of this decision, modal split follows automatically from the trip generation and attraction stage.

Traffic Assignment

Traffic assignment is the last stage of the traffic demand model and produces outputs (such as vehicle-km, vehicle-hours, travel speed, and congestion rates) that are used to assist in the evaluation of the feasibility of the OCH. In this study, the incremental traffic assignment model was applied because of its ease in checking route and link assignments. In this model, the principle of equal travel times is used. That is, traffic will switch to another route with shorter travel times and this process continues until there are no alternatives. Here, the calculation of travel time is important. To calculate travel time, the following information for the different types of road links is required: capacity, design speed, and speed-flow (QV) functions.

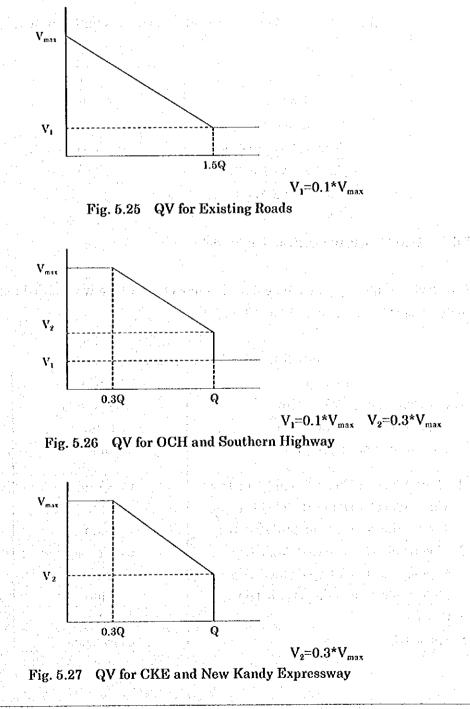
Three parameters that greatly affect the design speed and capacity of a road are geometry, terrain, and land use. Information on road capacity and design speed by road class (which is an expression of highway geometry), terrain, and land use was obtained from the RDA Design Standard. This information, along with design information from Japan used as a reference, was the major factor for setting the maximum daily design capacity for the existing links of the road network (see Tab.5.11). Capacity was then adjusted as necessary for narrowness using an adjustment factor from the American Highway Capacity Manual. As for design speed, it was determined instead that free flow speed would give a more accurate representation of travel on the network from a modeling point of view. Free flow speed was derived by referring to the CUTS survey and to this study's traffic survey. As for the CKE and New Kandy expressways and the OCH and Southern Highway, since Sri Lanka has no experience with this grade of road, Japanese standards were referred to in setting capacity and lane width.

Type of Road	Type of Terrain*	Land Use	Maximum Daily Design Capacity	Lane Width	Free Flow Speed (knt/h)
2 Lane A Class	Plain	Urban	25,000	3.10	40
		Suburban/Rural			45
4 Lanc A Class	Plain	Urban	50,000	3.70	45
4 Lane A Class	I JUIL	Suburban/Rural	50,000	5.70	50
2 Lane B Class	Plain	Urban	20,000	3.10	35
2 Lanc D Class	1 1410	Suburban/Rural	20,000	5.10	40
4 Lane B Class	Plain	Urban	40,000	3.70	40
4 Lane D Class	r jaju	Suburban/Rural	40,000	5.70	45
Expressway (CKE, New Kandy Rd.)	Plain	Suburban	72,000	3.50	90
OCH 4 lanes	Plain	Cubuchan	52,400	250	60
OCH 6 lanes	riain	Suburban	72,000	3.50	60
Southern Hwy & Rat- napura Hwy. In 2020	Plain	Suburban	52,400	3.50	60

Tab. 5.11 Daily Design Capacity and Free Flow Speeds for Road Network Links

*Since the CMR is mostly flat, only the terrain type plain was considered

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO As for selecting appropriate QV functions for the above road types, it was decided that those shown in figures 5.25, 5.26, and 5.27 would be used for existing roads, the OCH, and the CKE/New Kandy expressways, respectively. The logic behind this selection is basically that higher grade roads are able to sustain higher speeds at larger volumes. As for the difference between the expressways and the OCH and Southern Highway, since the former is a full-controlled facility, it is possible to close entrances to traffic when levels of service decrease to unacceptable levels.



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Finally, the mix of traffic is one other item that has to be taken into account in traffic assignment. This is usually handled by converting traffic into passenger car units (PCUs). It was decided to use the PCU standard established by the University of Moratuwa, which is based on Sri Lankan data, in order to sufficiently take into account local conditions. It should be mentioned that a weighted average for buses and trucks was used in the assignment model because of the different types that exist. An extract from the standard is shown in Tab.5.12 for those vehicles seen most commonly in Colombo.

Type of Vehicle	PCU
Passenger Car	1.00
3-Wheeler	0.75
Motorcycle	0.50
Minibus , Bus (two door)	1.60, 2.40
Light Truck, Medium Truck	1.50, 2.00

Tab. 5.12 PCU Values by Vehicle Type (excluding hilly terrain)

Note : Extract from Univ. of Moratuwa standard

5.4.3 Trip Generation/Attraction Model

The results of the trip generation/attraction modeling, which was carried out using regression analysis, are shown in Tab.5.13 and Tab. 5.14.

Тгір Туре	Variable	R ²
1. Car Home-Based Work Trip	Cars/capita	0.82
Car Home-Based Other Trip	Ditto	0.87
Car Non-Home-Based Trip	Ditto	0.85
2. Three-Wheeler Home-Based Work Trip	Cars/capita	0.79
Three-Wheeler Home-Based Other Trip	Ditto	0.88
Three-Wheeler Non-Home-Based Trip	Ditto	0.86
3. Motorcycle Home-Based Work Trip	Cars/capita	0.89
Motorcycle Home-Based Other Trip	Ditto	0.90
Motorcycle Non-Home-Based Trip	Ditto	0.86
4. Bus Trip	Population	0.70
5. Truck Trip	Cars/capita	0.87

Tab. 5.13 Vehicle Trip Generation Models

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Тгір Туре	Variable	R ²
1. Car Home-Based Work Trip	No. of Employed	0.55
Car Home-Based Other Trip	Population	0.68
Car Non-Home-Based Trip	Population	0.58
2. Three-Wheeler Home-Based Work Trip	No. of Employed	0.55
Three-Wheeler Home-Based Other Trip	Population	0.51
Three-Wheeler Non-Home-Based Trip	Population	0.64
3. Motorcycle Home-Based Work Trip	No. of Employed	0.53
Motorcycle Home-Based Other Trip	Population	0.41
Motorcycle Non-Home-Based Trip	Population	0.65
4. Bus Trips	Population	0.64
5. Truck Trips	Population	0.70

 Tab. 5.14
 Vehicle Trip Attraction Models

As Tab. 5.13 indicates, the vehicle trip generation models sufficiently explain trip making with an average R^2 (i.e., coefficient of determination) of 0.84. As for the vehicle attraction models, all of them have a lower R^2 when compared to the trip generation models, having an average R^2 of 0.58. This is the case actually in many transportation studies, as trip attraction is usually more difficult to model. Finally, although different socioeconomic factors were checked, it was discovered that cars/capita (which is a proxy for income), no. of employed, and population produced the most valid models in terms of logic and statistical soundness.

5.4.4 Trip Distribution Model

The type of trip distribution model chosen for this study is the widely applied gravity model (Voorhees type) and is as follows:

$$u_{j} = T_{i} \frac{U_{j} f(d_{ij})}{\sum_{k=1}^{n} U_{k} f(d_{ik})}$$

Where,

 T_i = vehicle trips generated

 U_j = vehicle trips attracted

 d_{ij} = distance between zones

 $f(d_{ij}) =$ function expressing the travel impedance between zones in terms of distance $f(d_{ij}) = d_{ij}^{-b}$

Vehicle trip distribution models were constructed using trip and vehicle type data. The desired line chart for all trip types is shown in Fig.5.28. As this figure indicates, the largest number of trips that is made is between Nugegoda and Colombo, Kelaniya and Colombo, Wattala and Colombo, and Kaduwella and Colombo. As for orbital types of trips, they are almost nonexistent and the vast majority of trips are radial in nature, with Colombo being the center of activity.

As Tab.5.15 indicates below, the trip distribution models are capable of simulating the actual distribution of trips quite well. That is, the R^2 was an average of 0.89 and, except for two of the models, all of them had a R^2 greater than 0.80. This means that on average the models were capable of explaining more than 80% of the variation in trip making The models were calibrated taking into consideration the following three factors:

(1) observed average trip length,

(2) the number of daily screen line trips (see Fig. 5.29), and

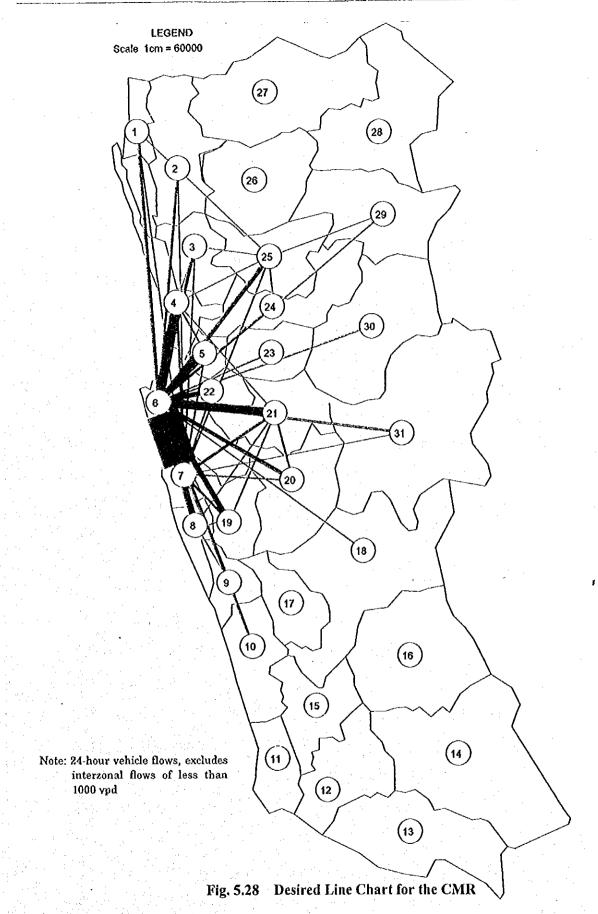
(3) the daily number of cordon line trips at the Western Provincial Boundary.

The data for these factors were obtained in the traffic surveys previously mentioned, as well as from data supplied by the RDA. As for the screen line and cordon line, the Kelani River was used as a screen line and the boundary of the Western Province as a cordon line. The calibrated trip distribution models were then used for deriving the future OD matrices for the years 2010 and 2020 (see Tab. 5.16 and 5.17 for the all purpose all vehicle type OD).

	Tab. 5.15 venicle Trip Distrib	ution widder Kest	ion would results		
· .	Ттір Турс	Estimated	Correlation		
·		Parameter	Coefficient		
	Home-Based Work Trip	-0.8	0.97		
Passenger car	Home-Based Other Trip	-0.6	0.94		
· .	Non-Home-Based Trip	-0.8	0.97		
	Home-Based Work Trip	-0.9	0.76		
3-Wheelers	Home-Based Other Trip	-1.0	0.95		
· · · · · · · · · · · · · · · · · · ·	Non-Home-Based Trip	-1.1	0.96		
	Home-Based Work Trip	-0.7	0.92		
Motorcycle	Home-Based Other Trip	-1.1	0.90		
	Non-Home-Based Trip	-0.6	0.95		
Truck	an Antonio antina antina antonio anti-	-1.4	0.80		
Bus		-0.6	0.73		

Tab. 5.15 Vehicle Trip Distribution Model Results

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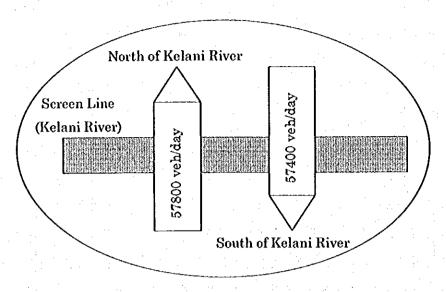
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Tab. 5.16 Vehicle OD Matrix for 2010 Pack 5-40	Tab. 5.16 Vehicle OD Matrix for 2010 Pace 5-40	- PAGE 5-40					
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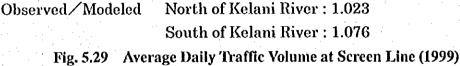
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5.4.5 Modal Split Model

A modal split model was not developed for the reasons previously given in the section on Modal Split in 5.4.2.

5.4.6 Traffic Assignment Model

The validity and calibration of the traffic assignment model was carried out comparing modeled and observed daily traffic flows at sites where traffic volume counts were executed (see Tab. 5.18), except for those sites with traffic flows of less than 10,000 vehicles per day. (Refer to Fig. 5.3 for site locations.)

As Tab. 5.18 indicates, the average deviation between estimated and observed flows is about 15%, which is acceptable from the strategic level of analysis that is being carried out for this study. Except for Site 29, the modeled and observed traffic flows for each site are generally acceptable. However, it should be noted that modeled flows are on average about 15% less than actual flows.

In terms of modeled and observed speed flows, modeled speed flows for all 8 of the major corridors in Colombo fall within the range of actual speeds observed (see Tab.5.19). Observed

average daily speed for all of the corridors was 32.7 km/h as compared to the modeled average of 33.6 km/h. Indicating that the traffic assignment model simulated overall traffic speeds satisfactorily.

Tab.5.18	Comparison of	Model Estimates with	Observed Traffic Volumes
Site	Model Total	Observed	Model/Observed
	(Vehicle)	(Vchicle)	
1	52200	60000	0.87
	37900	41800	0.91
3	9700	14900	0.65
4	39200	54500	0.72
5	28500	32200	0.89
6	20300	20600	0.99
. 7	34700	49200	0.71
8 9	25500	30000	0.85
9	21500	24300	0.88
11	16100	17000	0.95
13	7100	11000	0.65
16	12300	16000	0.77
17	14100	12900	1.09
19	46800	48100	0.97
20	31500	26400	1.19
21 492	16800	16300	1.03
23	9000	10200	0.88
26	19900	24000	0.83
27	9200	11700	0.79
28	13400	11500	1.17 Instantia
29	10100	21000	<u>eg da elector 0.48 entre a terra e</u>
30	5400	14100	0.38
31	16200	21300	0.76
34	17600	16800	1.05
Average			0.852

Tab. 5.18 Comparison of Model Estimates with Observed Traffic Volumes

Tab. 5.19 Comparison of Observed and Modeled Travel Speeds

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Route Line	Observed Da	ily Travel Speed	Modeled Daily Travel Speed
	Range	Average	Average
A1	29.3-39.0	34.4	35.7
A4	18.8-32.9	27.5	32.1
A104, A0	20.3-38.3	30.6	34.0
A3	29.8-46.5	38.3	40.3
A 44 (A 42 (A 5)	27.8-37.2	33.1	36.6
B84	25.4-39.8	30.0	25.5
B214	28.3-38.5	32.6	31.5
A110	31.5-40.3	35.3	32.8

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5.5 Future Traffic Demand

By applying the calibrated traffic assignment model above, forecasts for 2010 and 2020 are carried out after inputting the future road network for the target years of 2010 and 2020.

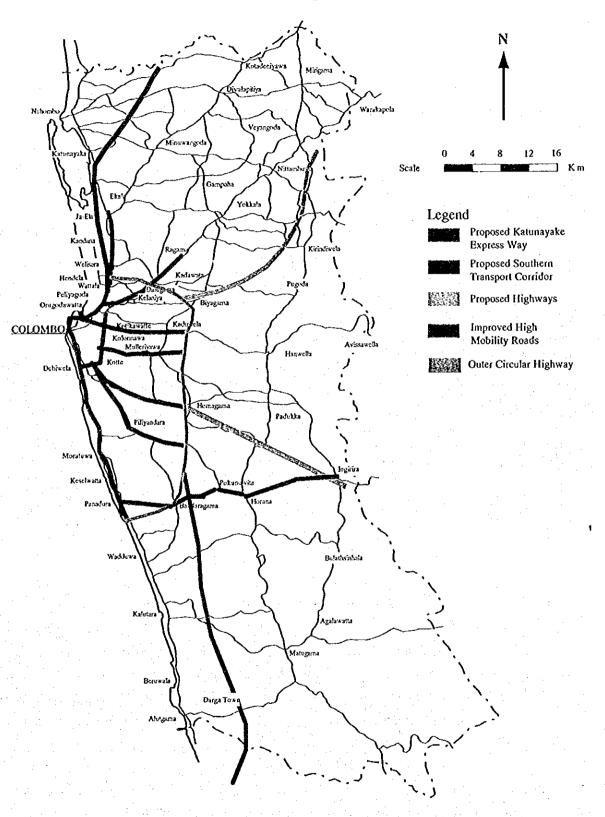
5.5.1 Future Road Network Improvements

To calculate future traffic demand for the OCH, it is imperative to consider future road construction and improvements. These are shown in Fig. 5.30. Except for the New Kandy Expressway, the new Ratnapura Road, and the northward extension from the airport (completion to be 2020), it is assumed that all road improvements and construction schemes will be completed by the year 2010.

1) New Road Construction

The new road construction considered in the model is as follows:

- (1) The Northeast Highway to Kandy: This route would improve access to the north (including Kandy) and east of the country and reduce congestion on Route A1 and A3. Its terminus in Colombo would be the northern entrance to the Baseline Road.
- (2) The Southeast Highway to Ratnapura: This route would connect the southern part of the Baseline road with Ratnapura and provide more access to areas in the outer suburbs of CMR to the core of the city.
- (3) The Katunayake Expressway: This alignment would be a fully-controlled toll road that would connect the City of Colombo with the city's international airport. The intention is to provide reliable, timely service for travelers going to/from the airport.
- (4) The Baseline Road Extension: This would extend the Baseline Road from its current southern terminus of Kirillapone straight to Attidiya in the south (or about 5.5 km), which would then extend down to Galle Road via an existing road.
- (5) The Katunayake-Padeniya Highway: This would further improve access to the airport and extends north beyond the boundary of the CMR to Padeniya in the North West Province.



Colombo Metropolitan Region



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New Road Improvements

Future road improvements for the CMR focus on improving the capacity of nine existing corridors to improve speeds to around 30-40 km/h. The total length of these corridors is 180 km and they would have as one of their main purposes the distribution of inter-regional traffic to the area of the Colombo Metropolitan Council and its suburbs. These nine corridors and the sections to be improved, as well as their length, are indicated in Tab. 5.18 below.

Tab. 5.20 High Mobility Corridors				
Name of Corridor	Location of Sect. for Improvement	Length of Sect. Improvement		
Route A1 (Colombo-Kandy Rd)	Up to Kadawatha interchange with North-South Highway.	18 km		
Route A2 (Colombo-Galle-Hambantota-Wellawaya Rd)	Up to Panadura	28 km		
Route A3 (Peliyagoda-Puttalam Road)	Up to Ja-El interchange with North- South Highway.	20 km		
Route A4 (Colombo-Ratnapura-Wellawaya-Batticaloa Rd)	Up to Kottawa interchange with North-South Highway.	22 km		
Route B84 (Colombo-Horana Rd)	Up to Polgasowita interchange with North-South Highway.	20 km		
Route A110 (Colombo-Hanwella Rd)	Up to Kaduwela interchange with North-South Highway	15 km		
Route A0 (Kollupitiya-Sri Jayawardena Pura Rd)	Up to Talangama interchange with North-South Highway.	15 km		
Route A8 (Panadura-Nambapana-Ratnapura Rd)	Up to Ingiria	34 km		
Baseline Road	Improved to dual 3-lane carriageway.	8 km		
Total		180 km		

Tah	5 20	Hioh	Mobility	Corridors
I a D.		11121	ITIUJJIII	COLLIGUES

Source: Based on data from Urban Development Authority, Colombo Metropolitan Structural Plan, Vol. II. 1998.

5.5.2 Traffic Demand Forecasts for 2010 & 2020

In addition to the future road improvements and construction mentioned in the previous section, 9 different possible alignments for the OCH were examined for possible incorporation into the future road network, which were decided in consultation with the RDA (see Chapter 8). Here, only the traffic demand forecast for the alignment that was selected as the most preferred route is taken up and examined for the future years of 2010 and 2020 in comparison to the case of no OCH being built. A comparison of the present situation with and without the existence of the OCH is also done for the purposes of reference.

In tables 5.21 to 5.23, the traffic indices of vehicle-kilometers, vehicle-hours, average area congestion, and average area speed are used to assess the impact of the OCH on the CMR.

1ab. 5.41	Comparison Ira	me impact with	and without the	
	Daily Veh-km For CMR (mil)	Daily Veh-hrs for CMR (mil)	Daily Average VCR	Daily Average Speed
Without OCH	8.99	0.26	0.47	32.7
With OCH	8.92	0.26	0.41	34.7
Ratio of with/without	0.99	1.00	0.87	1.06

 Tab. 5.21
 Comparison Traffic Impact with and without the OCH for 1999

Tab. 5.22 Comparison Traffic Impact with and without the OCH for 2010

	Daily Veh-km for CMR (mil)	Daily Veh-hrs for CMR (mil)	Daily Average VCR	Daily Average Speed
Without OCH	19.69	0.71	0.83	27.7
With OCH	19.57	0.65	0.73	30.3
Ratio of with/without	0.99	0.92	0.88	1.09

Tab. 5.23 Comparison Traffic Impact with and without the OCH for 2020

	Daily Veh-km	Daily Veh-hrs	Daily Average	Daily Average
	for CMR (mil)	for CMR (mil)	VCR	Speed
Without OCH	30.11	1.20	1.06	25.2
With OCH	29.40	1.04	0.92	28.4
Ratio of with/without	0.98	0.87	0.87	1.13

The conclusions that can be drawn from the construction of the OCH based on the above tables are as follows:

- 1) The impact of the OCH becomes larger as time passes by. In the year 2020, the construction of the OCH would result in daily area speeds being 1.13 times faster as compared to only 1.06 times faster if the OCH was in existence today. In the year 2010, the construction of the OCH would result in average area travel speeds being 1.09 times faster.
- 2) The reduction in distance traveled on the road network with the introduction of the OCH is slight. In the year 2010 it is a small 1% and would reach 2.4% in the year 2020, indicating an increase in the number of orbital trips. On the other hand, vehicle-hours would be 11% and 13% less in the years 2010 and 2020, respectively, as compared to the case of there being no OCH.
- 3) The difference in actual area travel speeds with and without the OCH is 2.7 km/h in 2010 and 3.2 km/h in 2020. These are substantial differences in speed for an urban area.

4) Area wide congestion with the OCH would be about 12% less as compared to without.

The above clearly indicates that the OCH would be a feasible proposition from the perspective of the impact that it would have on area-wide traffic. As for the traffic demand on the OCH itself, estimates by this study indicate that the OCH would be a highly traveled facility. For example, in the year 2010, a daily total of about 91,000 vehicles would use the OCH, while in 2020 this total would be about 142,000 vehicles per day. The average traffic flow for a section of road on the OCH would be about 37,000 pcus in 2010 and 45,100 pcus in 2020. Given these traffic volumes, it is suggested that the OCH be constructed initially as a 4-lane facility. The most congested parts of the OCH would be located in the middle of this ring road and the least congested parts at the tail ends. However, as shown in Fig.5.31 for 2010, the northern tail end would have a much higher traffic volume (34,500 pcus) as compared to the southern tail end (19,200 pcus).

In the year 2020, pcus flows indicate that the entire middle portion of the OCH is over capacity. Although a 4-lane OCH facility is sufficient to handle the required traffic flows in the year 2010, improvements to the OCH will be necessary to handle the traffic generated in the year 2020. Except for the southern tail end of the OCH, it is suggested that the OCH be made into a 6-lane facility for the year 2020. Although traffic on the northern tail end and on the section between A8 and the Southern Highway can be handled by a 4-lane structure, it would be better from a network point of view to make these 2 sections into 6-lane structures as well. That is, because the northern tail end would connect the important CKE with the 6-lane portion of the OCH, which intersects the busy Kadawata area, it would be in the long run strategically better for the northern tail end to become a 6-lane facility. In the case of the OCH portion between A8 and the Southern Highway, it is quite short in length (less than 1 km) and it would be rather pointless to only retain this section of the OCH straightaway as a 4-lane structure. As for the southern tail end of the OCH, its traffic demand of 28,200 pcus requires that it remain as a 4-lane structure.

Given the above, it can be said that the OCH is viable and necessary for the Colombo Metro Region.

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FINAL REPORT

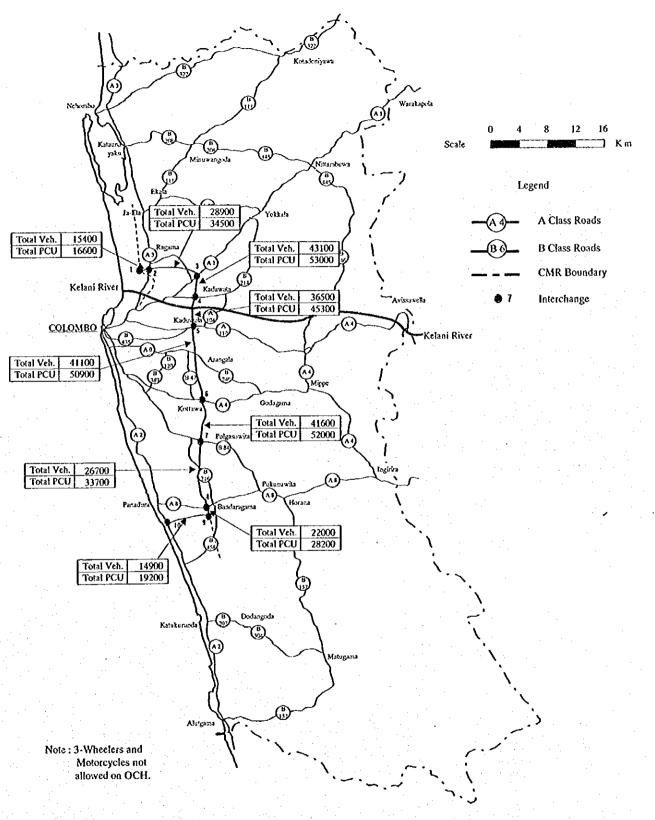


Fig. 5.31 Traffic Volume (both directions) for Road Links of Outer Circular Highway for 2010 for Most Appropriate Alignment

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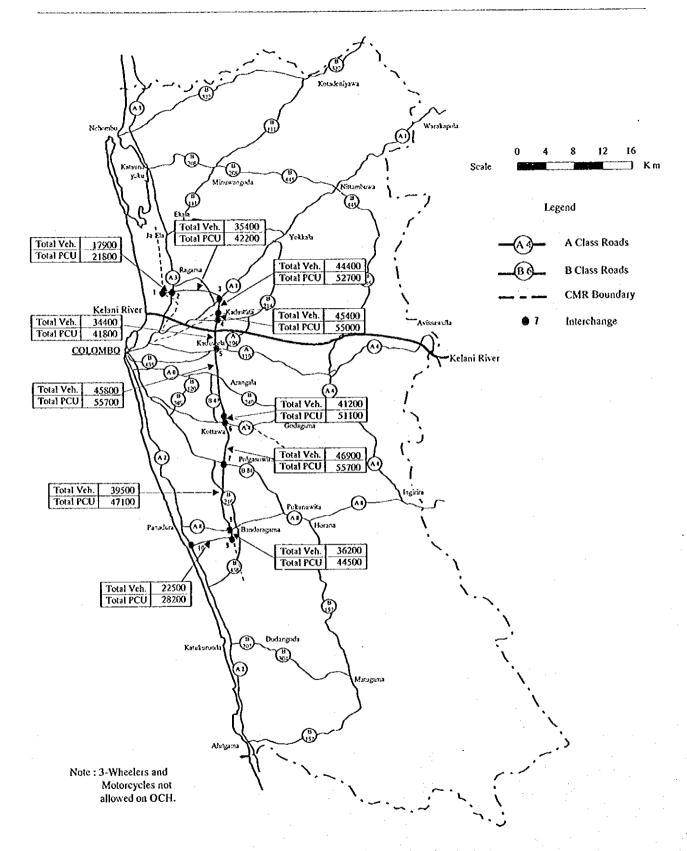
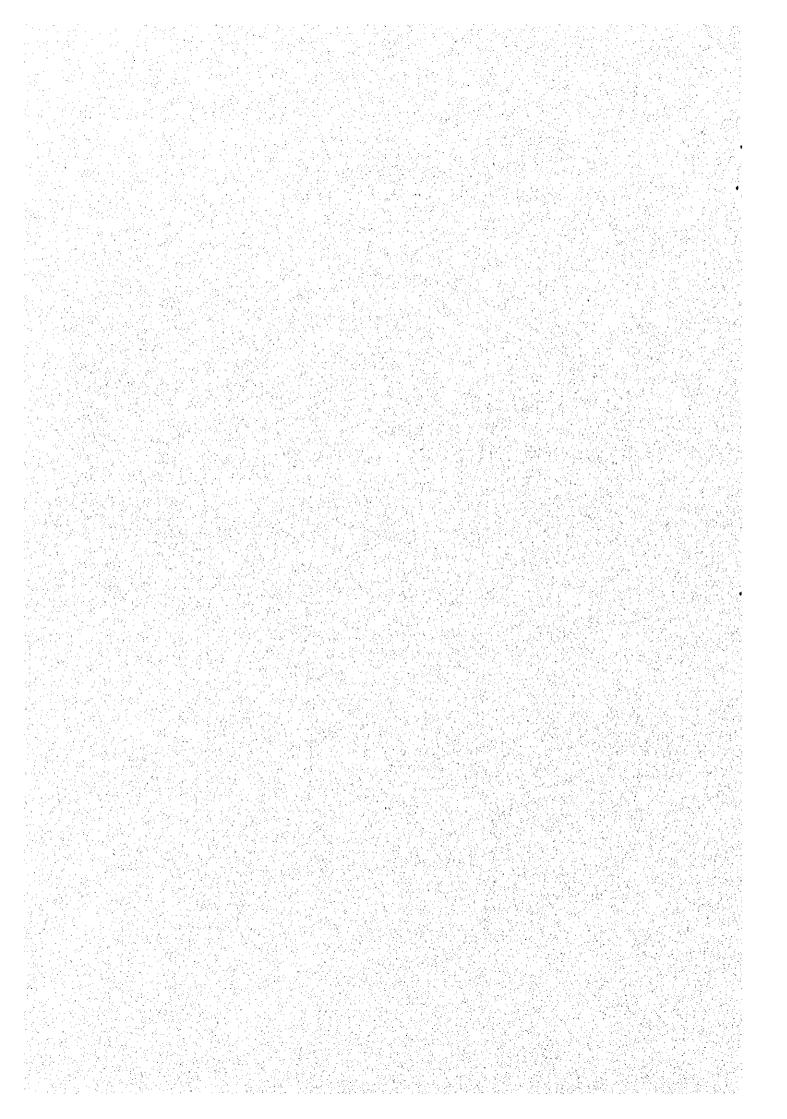


Fig. 5.32 Traffic Volume (both directions) for Road Links of Outer Circular Ilighway for 2020 for Most Appropriate Alignment

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CHAPTER 6

ENGINEERING SURVEY



CHAPTER 6 ENGINEERING SURVEY

6.1 Aerial Photograph Survey

Only the Survey Department of Sri Lanka is to be allowed to carry out the aerial photograph survey in Sri Lanka. There are no private firms capable for carrying out this survey. The aerial coverage is approximately 40km in length and 10km in width and consists of about 545km². Of these 545km², approximately 30% have been carried out by the Southern Transport Corridor Project. The new aerial photographs which have been taken by the Survey Department, have been applied for further processing such as photo mosaics with a scale of 1/20,000, topographic mapping, and etc.,

6.1.1 Air Survey

1) Study Area

The Study area is in the Colombo Metropolitan Region(CMR) which is representative of the Western Province and consists of the three administrative districts of Gampaha, Colombo and Kalutara. Total (approx. area : 545km²)

2) Flight Period

Aerial Photograph survey has been carried out in February, 1999.

3) Flight Specification

The fright specification to be applied for the aerial photograph is as follows:

(1) Aircraft

- Aircraft : Ceisna 441C
- Camera : WILDRC20
- Lens: 15/4UAG-F ; forcal length: 153mm
- Filter : 450mm
- Film : Agfa Pan 200 PEI
- (2) Specification
 - Flight Altitude : 3,000m(M.S.L)
 - Photography Scale : 1: 20,000
 - Flight Courses : 8 lines (Southern Highway Project : 6 lines) Total 14lines
 - Overlap: 60 %
 - Side lap : 30%
 - Crab : less than 10 degrees
 - Tip & Tilt : less than 5 degrees

FINAL REPORT

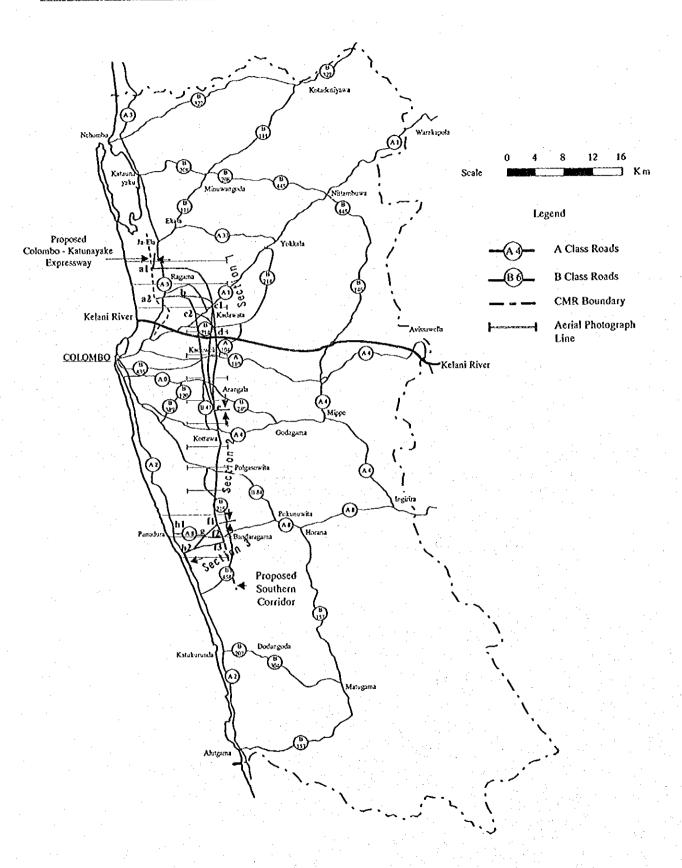


Fig 6.1 Orientation Map of Aerial Photograph

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JICA STUDY TEAM ORIENTAL CONSULTANTS CO., LTD. Area Coverage : approx.377km² (Southern Transport Corridor Project:168km²) Total 545km²

The orientation map of aerial photograph is shown in Figure-6.1

4) Photo Processing

The photo processing has been carried out in the photo laboratory of the Survey Department and the photo processing equipment is shown as follows:

Film Processor : Agfa Graviton 66

- Developer : Agfa G74C Contact Printer : KG 30 printer
- Picture Size : 23×23 cm

5) Digital Photograph Mosaic (Operation in Japan) The aerial photographs were taken back to Japan for further processing upon the obtaining approval from the Ministry of Defense. The aerial photographs were digitized by scanning and were compiled as photograph mosaic data in the following manner :

(1) Scanning and digitalization of aerial photographs

The aerial photographs are scanned with resolution of 800 dpi.

(2) Digital Mosaic

Digital photograph data are retrieved and shown on screen, and the photograph images are connected one by one.

(3) Compilation and Original Mosaic

Mosaic sheets are arranged according to the index map. Major roads and rivers are annotated on the monitor as original mosaic data. Original mosaic data are compiled by providing marginal information, such as photograph mosaic scale, sheet number, adjoining sheet map and north direction.

(4) Output

Final results are produced by laser plotter at 800 dpi. resolution

(5) Main Equipment to be used

Software : ER Mapper 5.2

Scanner : UMAX ; Mirage II , CPU; Pentium 150, Hard disk, 2.5GB

Computer : CPU ; Pentium 233(RAM 64 MB), Hard disk, 6 GB

Laser Plotter : Lightjet 5000

6.1.2 Creation of Digital Photo-Mosaics for Route Selection

In order to examine and determine concrete routes, previous aerial photos were used to create photo-mosaics. Colour tone variations between photos were corrected, and the photo-mosaics were digitised in order to optimise them for route selection.

The digital photo-mosaics created were as follows:

- * Scale of 1:20,000 1 set
- * Scale of 1:120,000 1 set

The planned routes were represented on the 1:20,000-scale digital photo-mosaic. The necessary geographic names were indicated on the 1:120,000-scale digital photo-mosaic.

6.1.3 Ground Survey

The ground survey consisted of photo control survey, levelling, cross section survey and field survey, and was conducted in accordance with the following work quantities and specifications:

* Photo control survey

Work quantity: 16 points

Specifications:

Method Static relative positioning using GPS		
Equipment used	Single- or dual-frequency GPS receivers	
Observation time	A minimum of 1 hour	
Number of observed sa	atellites by the second second second second	
	A minimum of 4 satellites	

Linked to other control points

* Levelling

Work quantity: 94 km (installation of 10 bench marks)

Others

Specifications:	Method	Junction or reciprocal observations
an shi biri	Equipment used:	Auto-level
	Observation distance	Less than 80m
	Interval between prick	king points
		$200 \sim 400 \mathrm{m}$

Closing error $50 \text{ mm } \sqrt{S}$ (S = Route length in km)

Cross section survey

Work quantity:	3 sections (Kelani Ga	anga)	
	3 sections (Bolgoda (langa)	
Specifications:	Plotting scale	H = 1:500, V = 1:2	00

* Field survey

Work quantity: 50 km²

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(1) Photo Control Survey

The control points necessary for aerial triangulation and plotting were selected and pricked on the aerial photos. Piles were installed in the field.

After installing piles at each control point, GPS observations with 5 satellites were conducted for at least 1 hour using 5 GPS receivers.

2 Levelling

Levelling routes were decided based on aerial photos and field reconnaissance, and new bench marks were installed at the necessary points. Levelling was conducted along the routes planned, based on existing bench marks. Pricking locations were chosen at clear landmarks on the aerial photos. Then, the elevations of control points located on or near the planned routes were measured.

(3) Cross Section Survey

The river cross section survey was conducted for a total of 6 sections in 2 areas. GPS control points and newly established bench marks were used as standards for horizontal positions and vertical positions respectively. The cross section survey necessarily included the observation of critical points (change of slope). The acquired digital data were plotted (represented) at the specified scale using computer software.

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(4) Field Survey the off a constrained of the offer a state of the second state of the

Information necessary for the representation of topography but not obtainable by photointerpretation were identified in the field, and the results were indicated on the photos in view of digital plotting and digital compilation operations. Administrative names and boundaries were decided based on the collected 1:50,000 and 1:10,000 topographic maps.

6.1.4 Photogrammetry

(1) Aerial Photogrammetry

Aerial photogrammetry entailed determining pass point coordinates for each model, as they were necessary for subsequent digital plotting operations. The bundle adjustment method was used for this calculation. The residual mean square errors at each control point, which show the accuracy of the results, were good, at 0.211 m (horizontal position) and 0.364 m (vertical position).

Work quantity: Adjustment method: 13 lines, 57 models Bundle adjustment method

	Comparator:	Stecometer	:	a statistica de la companya
1	and the second		a tha in t	
	② Digital Plotting	an a	ate le tra	
	Topographic and planime	tric features were digi	itally plotte	d, using aerial photogrammetr
	and field survey results.	A special code was as:	signed to ea	ach topographic and planimetr
	feature to ensure the adva	anced use of data obtai	ned.	
	Work quantity:	1:2,000 10.	.06 km²	
	an a	1:5,000 40,	,74 km²	
· 1.	Equipment used:	Analytical plotter	e DSR14, SE	DR2000
- <u>-</u> -	en e	an an taong taon an 1990.	jandro de do	
1.4.1	③ Digital Compilation	n to an Europe (Berl		
				l by digital plotting and the fiel
	survey results, and in a	cordance with map s	ymbol speci	ifications. The data obtained l
	digital compilation were s			
	Work quantity:			
e Server	e fil e se s		1	
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	base laser printouts were			· · · · · · · · · · · · · · · · · · ·
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OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

6.2 Natural Conditions Survey

6.2.1 Work in Sri Lanka

The JICA study team conducted studies on literatures and existing data and field survey during a period from January to February 1999 mainly in terms of the following items:

(1) Geological and topographical surveys along the route

(2) Collection of existing boring data, etc. on the study area from RDA and other sources

(3) Topographical study on alternative routes along with the field survey result based on the 1/50,000 and 1/10,000 topographic maps leased from the Survey Department of Sri Lanka

The review was made on the basis of above investigation results concerning (a) prediction of flood run-off through the valley topography that crosses the route, (b) investigation on the borrow pits in the neighborhood of the route to soil availability in terms of the topography and geology, etc.

From May to July, 1999, the JICA study team contracted the following natural conditions survey to a local research company to ensure the accuracy of outline design concerning the optimum route selected for detailed study. The Team was in charge of planning and supervision of the study.

(4) Geotechnical investigation and collection of hydrological data

Survey items		Work quantity	en dage av ag		··
Mechanical b	oring (land section)	8 points Total	of boring length	112 m	ul p
ditto	(river section)	5 points	ditto	53m	
ditto	(marsh section)	2 points	ditto	30m	
		Grand to	tal of boring lengt	h195m	

Undisturbed soil sampli	ing (fixed piston sampler)		17samples
Standard penetration test (each 1m)			132numbers
Portable cone penetration	on test points Total of penetration	length :	23m
(Machintosh test)			•
Field CBR test	e. A service a second s	8points	16numbers
Compaction test of dist	urbed soil (Proctor) and CBR test	17points	17numbers
Undisturbed CBR samp	les and CBR test	17points	17numbers
Soil test in laboratory:	Particle size distribution		142samples
	Specific gravity		156samples
en de la companya de La companya de la comp	Atterberg test (liquid limit and plastic	limit)	39samples
	Ignition loss		20samples
An	Unconfined compression test		44samples
	Consolidation test		39samples

Collection of hydrological data

Max. flood run-off study data for crossing points of Kelani and Bolgoda Rivers.

Daily rainfall data (1974 – 1999):

Angoda, Bandaragama and Horana monitoring observatories Source: Department of Meteorology

Mean daily flow (1972 - 1998): Hanwella observatory (Kelani River)

Source: Department of Irrigation

Flood stage along the route (Interview with local residents)

6.2.2 Topography

The route is mostly planned in the inland, that is, in the hilly topography around Colombo about 5 – 15 km from the coast. Only the start point (near the route A3 at a junction with the Colombo Katunayake Expressway in the north) and end point (near junction with the national road A2 in the south) are located in the littoral alluvial lowland near the coast. The hilly topography includes undulating hills with an elevation of 10 - 35 m or less that consists of pre-Cambrian bedrock and its weathered soil and the alluvial lowland developing along dendritic water systems (valleys, morass, streams) where flood plain sediments (sand, silt, clay, gravel) originating from weathered soil were deposited dissecting the hills.

PAGE 6-8

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO

JICA STUDY TEAM ORIETNTAL CONSULTANTS CO., LTD The route crosses two water systems. The system portion that is to the north and central section of the route runs off into Kelani River while the portion to the south runs off into Bolgoda River and lake, both via the dendritic water system.

In the inland area along the selected route, the hills with the elevation of 5 - 10 m or more have the wide-ranging housing area and coconut plantations and various crop fields. Namely, this is a land already developed for high-level utilization. Therefore, the alignment employed for the route is to pass through the boundary between the hill slope end and the lowland, swamp (with the elevation of less than 5 - 15 m) used for the paddy along the stream and flat paddies.

On the other hand, the topography from the area near the coast at start and end points of the route facing the Indian Ocean ranges from the coastal alluvial lowland to backland swamp with the elevation of 0 - 5.6 m or less. Except for the area along the national highway, most of the lands are either unused or used only partially.

As a whole, the optimum route will have an alignment to pass the unused lowland and low swamp. Fig. 6.2.1 shows the percentage of elevation at which the center line of optimum route passes. It is found that 70% of the entire route passes through the land where the elevation is 10 m or less.

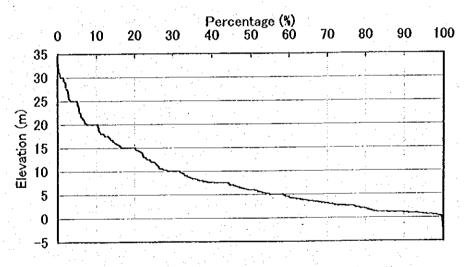


Fig-6.2.1 Elevation distribution of Longitudinal profile

The topography is classified as follows along the station (STA) of the optimum route: (STA indicates the distance from the junction of CKE which are on the Preliminary Drawings)

(1) CKE (Colombo Katunayake Expressway) - A1 Road

STA -7 - STA6: Alluvial lowland with the elevation ranging from 0 to 5 m

STA6 -- STA16: Hilly topography with the elevation of 5 m

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STA16 - STA43:	Peat land of backland swamp with the elevation of 0 m
STA43 – STA53:	Crossing ridges of the hilly topography with the elevation ranging from 10
	to 30 m
STA53 – STA62:	Passing through paddies in the dendritic system with the elevation ranging
	from 2 to 5 m
STA62 - STA77:	Hilly topography with the clevation ranging from 20 to 30 m
STA77 – STA82:	Passing through paddies in the dendritic system with the elevation of 10 m

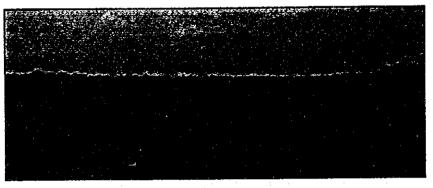


Photo 6.2.1 Boggy area at Nawanmehara Marsh : near STA24

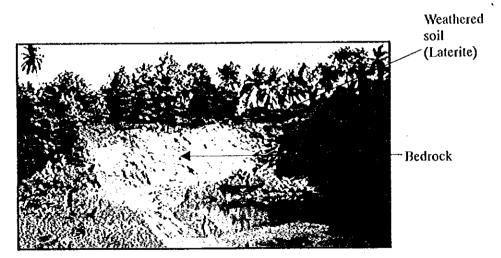


Photo 6.2.2 Old Rock Quarry at Ihara Karagahamura : near STA70

(2) A1 Road - A4 Road

STA82 - STA90:	Passing through paddies in the dendritic system with the elevation of 10 m
STA90 - STA96:	Crossing ridges of the hilly topography with the elevation ranging from 15
	to 25 m
00107 077100-	Descine through metaling in the dendritic system with the elevation of 8 m

STA96 – STA98: Passing through paddies in the dendritic system with the elevation of 8 m

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- STA98 STA104: Crossing ridges of the hilly topography with the elevation ranging from 15 to 25 m
- STA104 STA108: Passing through paddies in the dendritic system with the elevation of 10 m
- STA108 STA115: Hilly topography with the elevation ranging from 15 to 35 m
- STA115 STA121: Valley in the hilly topography with the elevation of 10 m
- STA121 STA123: Passing through paddies in the dendritic system with the elevation of 15 m
- STA123 STA126: Hilly topography with the elevation ranging from 10 to 15 m
- STA126 STA136: Paddies in the dendritic system with the elevation ranging from 2 to 3 m
- STA136 STA138: Crossing ridges of the hilly topography with the elevation ranging from 10 to 15 m
- STA138 STA140: Passing through paddies in the dendritic system with the elevation ranging from 2 to 3 m
- STA140 STA147: Hilly topography with the elevation ranging from 10 to 18 m
- STA147 STA151: Passing through paddies in the dendritic system with the elevation ranging from 2 to 5 m
- STA151 STA154: Hilly topography with the elevation ranging from 5 to 10 m
- STA154 STA160: Backland with the elevation ranging from 1 to 3 m. Former laterite borrow pit
- STA160 -- STA163: Kelani river and its bank topography.
- STA163 STA167: Hilly topography with the elevation ranging from 5 to 8 m.
- STA 167 STA174: Lowland in the dendritic system with the elevation ranging from 3 to 4 m
- STA174 STA177: Hilly topography with the clevation ranging from 5 to 15 m.
- STA 177 -- STA181: Paddies and hills in the dendritic system with the elevation ranging from 5 to 6 m
- STA181 STA187: Hilly topography with the elevation ranging from 15 to 25 m.
- STA 187 STA192: Paddies and hills in the dendritic system with the elevation ranging from 3 to 4 m
- STA192 STA198: Hilly topography with the elevation ranging from 15 to 20 m.
- STA 198 STA199: Passing through paddies in the dendritic system with the elevation of 10 m
- STA199 STA207: Hilly topography with the elevation ranging from 15 to 20 m.
- STA 207 STA208: Passing through paddies in the dendritic system with the elevation of 8 m
- STA208 STA211: Hilly topography with the elevation ranging from 15 to 20 m.

- STA211 STA237: Paddy boundary in the dendritic system with the elevation ranging from 5 to 10 m
- STA237 STA243: Hilly topography with the elevation ranging from 10 to 22 m.
- STA 243 STA245: Passing through paddies in the dendritic system with the elevation of 15 m
- STA245 STA250: Hilly topography with the elevation ranging from 20 to 30 m.
- STA 250 STA277: Paddies in the dendritic system with the elevation ranging from 10 to 18 m



Photo 6.2.3 Topographic view of paddy and low hills around STA90

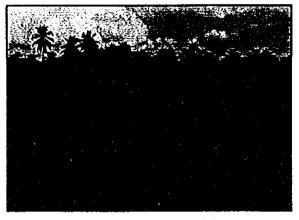


Photo 6.2.4 Kelani river at STA161



Photo 6.2.5 A view on A4 road at STA277 toward Colombo

(3) A4 Road -- Southern Connection

- STA277 STA320: Paddies in the dendritic system with the elevation ranging from 5 to 10 m
- STA320 STA359: Paddies in the dendritic system with the elevation ranging from 3 to 5 m
- STA359 STA365: Hilly topography with the elevation ranging from 10 to 20 m.
- STA365 STA372: Paddies in the dendritic system with the elevation ranging from 2 to 4 m
- STA372 STA377: Paddies in the dendritic system with the elevation ranging from 5 to 10 m
- STA377 STA387: Hilly topography with the elevation ranging from 10 to 25 m.
- STA387 STA389: Paddies in the dendritic system with the elevation of 5 m
- STA389 STA393: Paddies and hills in the dendritic system with the elevation ranging from 10 to 22 m
- STA393 STA401: Hpaddies in the dendric system with the elevation ranging from 2 to 4 m
- STA401 STA404: Crossing ridges of the hilly topography with the elevation ranging from 5 to 10 m
- STA404 STA413: Lowland swamp with the elevation ranging from 1 to 4 m on the bank of Bolgoda river
- STA413 STA416: Crossing ridges of the hilly topography with the elevation ranging from 5 to 6 m
- STA416 STA427: Lowland swamp with the elevation ranging from 1 to 4 m on the bank of Bolgoda river
- STA427 STA431: Crossing ridges of the hilly topography with the elevation ranging from 6 to 7 m
- STA431 STA434: Lowland swamp with the elevation ranging from 1 to 2 m on the bank of Bolgoda river

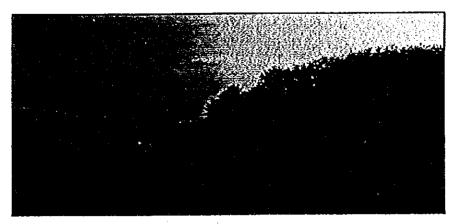


Photo 6.2.6 Topographic view of paddy and round hill at STA295

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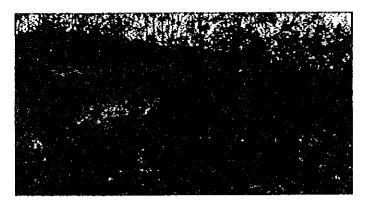


Photo 6.2.7 Representative cut of Laterite near STA330

(4) Southern Connection – A2 Road

- STA434 STA442: Lowland swamp with the elevation ranging from 0 to 1 m on the bank of Bolgoda river
- STA442 STA444: Bolgoda river and its bank topography.
- STA444 STA450: Lowland swamp with the elevation ranging from 1 to 2 m on the bank of Bolgoda river
- STA450 STA453: Crossing ridges of the hilly topography with the elevation ranging from 2 to 3 m
- STA453 STA458: Lowland swamp in the dendritic system with the elevation ranging from 1 to 2 m
- STA458 STA460: Crossing ridges of the hilly topography with the elevation ranging from 2 to 3 m
- STA460 STA469: Lowland swamp in the dendritic system with the elevation ranging from 1 to 2 m
- STA469 STA475: Crossing ridges of the hilly topography with the elevation ranging from 3 to 8 m
- STA475 STA492: Lowland swamp with the elevation ranging from 1 to 2 m on the bank of Bolgoda lake
- STA492 STA506: Alluvial lowland with the elevation ranging from 3 to 6 m

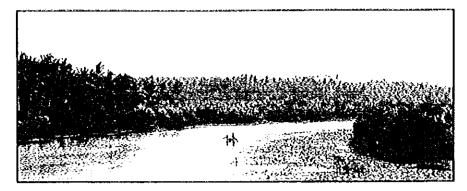


Photo 6.2.8 Bolgoda river near STA443



Photo 6.2.9 Topographic view of low hill and low land near STA460

6.2.3 Geology

Lowlands (paddies) and valley with the elevation of 10 m or less, which account for 70% of the inland route, have flood plain deposit. The deposit ranging from 1 - 2 m under the ground is mostly soft clayey soil to loose sandy soil with relatively uneven grain size. Peat and organic clayey soil may often intervene thinly in the above flood plain deposit layer, but are distributed mainly in backland marsh or swamp. In the swamp near STA24, thick deposit of peat was confirmed on the route in this field survey.

In the hills along the route, there are cuts and quarries where bedrock outcrops. Generally, the ground is covered with reddish-colored laterite (weathered soil) to a thickness of several to more than 10 m. Bedrocks distributed in the project area include gneiss, charnokites, and granite, and the weathered to fresh portions of gneiss and granitic gneiss were confirmed during boring this time.

The field survey this time confirmed distribution mainly of sandy soil in the alluvial lowland near the coastal area (near start and end points). According to the existing data, a drowned valley and peat and clay layers of old backland marsh intervene in certain areas. The lower weathered bed rock is covered to a thickness of several meters to more than 10 m with the peat in the backland marsh observed in many points of the area from start and end points and with the alluvial layer comprising sandy, gravely, and clayey soils in the lowland in the dendritic water system. It appears from data obtained through boring and analysis of existing data that the peat which is soft and may present problem for road construction will not exceed 10 m in layer thickness.



Photo 6.2.10 Varying thickness of Laterite covering the base rock, near STA70

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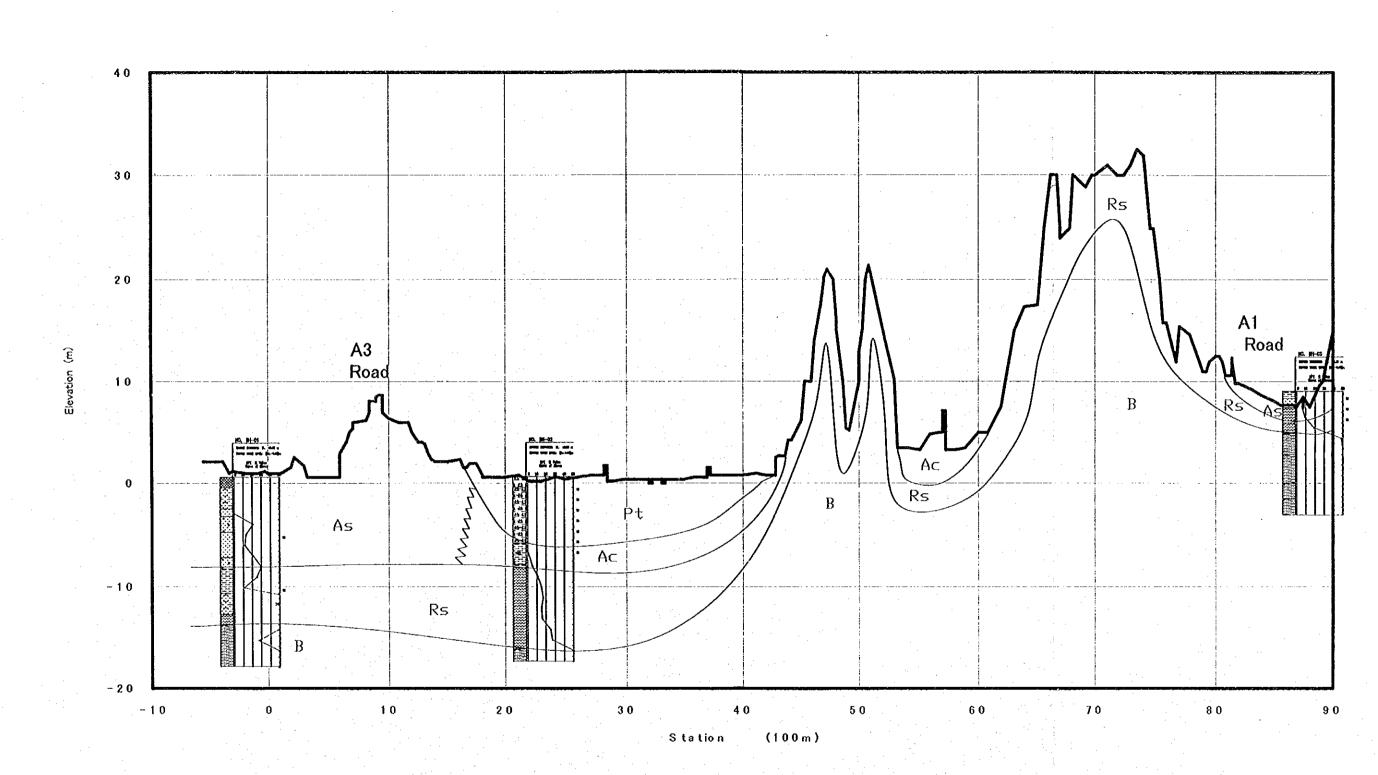
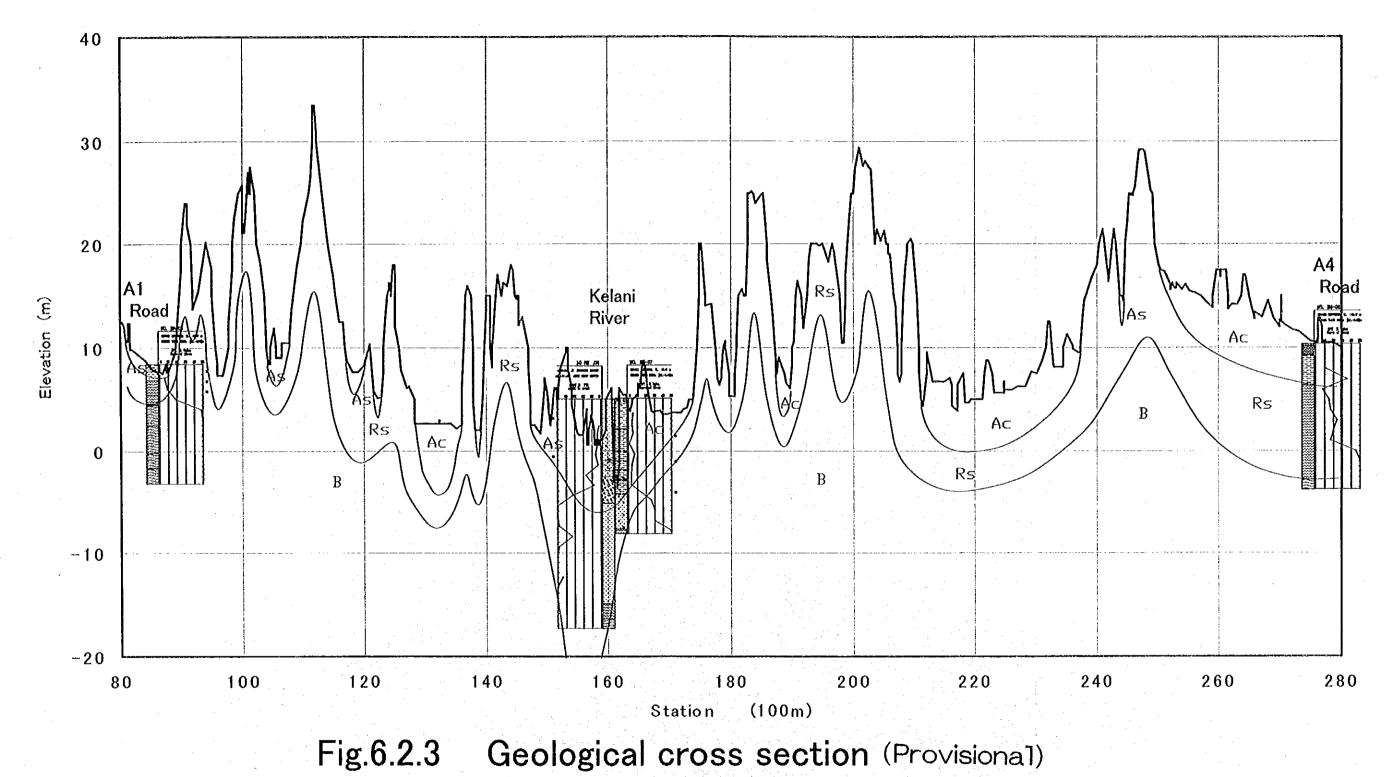


Fig.6.2.2

Geological cross section (Provisional) (Section : Katunayake Expressway to A1 Road)



(Section : A1 Road to A4 Road)

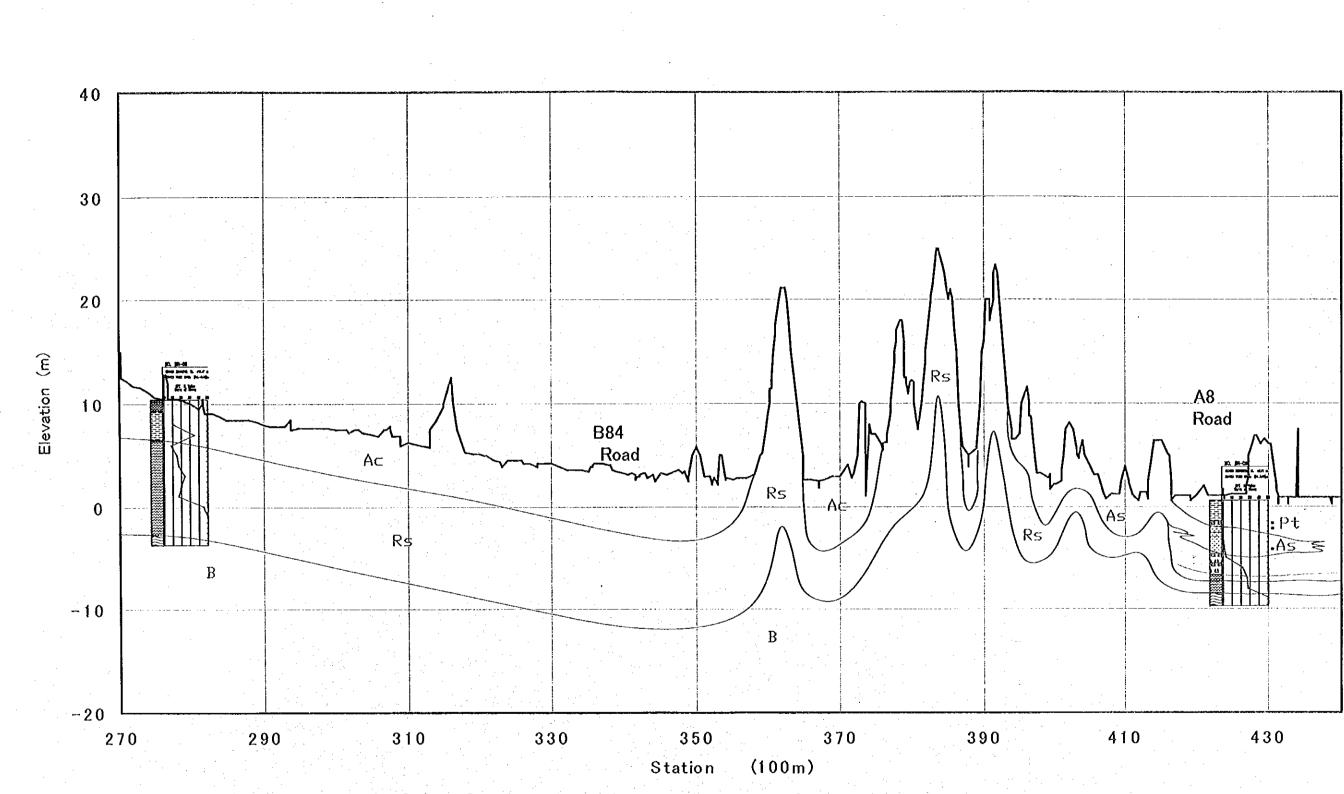


Fig.6.2.4 Geological cross section (Provisional) (Section : A4 Road to Southern connection)

